REMARKS

Claims 1-13 stand rejected under 35 USC 102(b), as anticipated by Yamazaki et al., (Mori Seiki Co. Ltd. et al.), EP 1027954 A1. This rejection is respectfully traversed.

Yamazaki discloses a tool management method, for determining when a cutting tool is to be retired from cutting, using: (i) an NC (numerical controlled machine) software program; (ii) tool information; (iii) cutting condition information; and (iv) information on the cutting tool state obtained as a result of performing machining simulations using the NC program.

Specifically, Yamazaki discloses four embodiments of methods for generating a tool wear database wherein, based on said tool wear database information, a software operated usability decision unit decides when a tool is to be retired. The four Yamazaki embodiments are:

Embodiment 1:

(a) extracting tool information and cutting condition information from an NC program;

(b) obtaining cutting status information from a machining simulation based on the NC program;

(c) measuring actual tool wear at the time of actual cutting; and

d) creating a tool wear database, of tool cutting length and tool wear obtained from the information from steps (a) - (c) above.

Embodiment 2:

(a) extracting tool information and cutting condition information from an NC program;

(b) obtaining cutting status information from a machining simulation based on the NC program;

(c) measuring surface roughness of an actually cut workpiece; and

(d) creating a tool wear database, of tool cutting length and tool wear obtained from the information from steps (a) - (c) above.

Embodiment 3:

(a) extracting tool information and cutting condition information from an NC program;

(b) obtaining cutting status information from a machining simulation based on the NC program;

(c) measuring actual tool wear during actual cutting;

(d) creating a tool wear database, of tool cutting length and tool wear obtained from the information from steps (a) - (c) above; and

(e) estimating the tool wear at the time when the relevant machining was performed using the tool wear database before actual machining is performed.

Embodiment 4

(a) extracting tool information and cutting condition information from an NC program;

(b) obtaining cutting status information from a machining simulation based on the NC program;

(c) measuring actual tool wear during actual cutting;

(d) creating a tool wear database, of tool cutting length and tool wear obtained from the information from steps (a) - (c) above;

(e) estimating the tool wear at the time when the relevant machining was performed using the tool wear database before actual machining is performed; and

(f) granting permission for actual machining by comparing the estimated tool wear and the tool life database.

The purpose of Yamazaki is to determine when to retire a cutting tool and not to specifically adjust his NC machine to compensate for ongoing tool wear during a cutting operation. As a result, the focus of the Yamazaki method is to develop a tool wear database from which information is used to determine if a tool is to be retired. See Yamazaki Fig. 1.

Claims 1-13 stand rejected under 35 USC 102(b), as being anticipated by Huffman US 4,186,529. This rejection is also respectfully traversed.

Huffman discloses a CNC machine with a grinding wheel wear compensation program. The wear compensation program is preset to modify machine movements when grinding successive workpieces, in order to adjust for the marginal wear on the grinding wheel.

Huffman first calibrates his CNC machine manually. This calibration sets up all of the machine reference axes with respect to the machine's cutting/grinding element and the mounting position and size of the workpiece. A grinding operation is performed on a workpiece at programmed feeds, timing and speeds. This replaces the previous requirement for operator manual adjustment of these cutting machine functions.

With Huffman, the grinding wheel wear (cutting tool wear) is predetermined (predicted) based upon previous experience -- grinding wheel wear manually observed for the size, speed and hardness of the grinding wheel, and the size and hardness of the workpiece - - and entered into his CNC program.

Huffman provides for the changing of the affected positions of the CNC machine, sequentially, to compensate for grinding wheel wear, only after a first workpiece is completed and before the grinding on a second workpiece begins. This eliminates the need for the operator to re-calibrate the CNC machine when each successive workpiece is mounted onto the machine. This compensates for an old worn grinding wheel verses a new grinding wheel.

Huffman is not concerned with adjusting his machine cutting control during the machining (grinding) of one workpiece. Huffman provides no means for adjusting his cutting control before the machining on a particular workpiece is completed.

Applicants' claimed method invention significantly departs, both from the Yamazaki disclosure and from the Huffman disclosure. These references, individually or in combination, neither disclose nor suggest applicants' invention as now claimed herein above.

Applicants do not focus on when to retire a cutting tool. To the contrary, applicants focus on adjusting machine operating parameters based on actual measured wear taken during

an interruption in cutting and an estimation of wear based upon the immediately previous machine parameters including feeds, timing and speeds, and tool and workpiece hardness, etc.

Applicants' invention includes a wear estimation algorithm. This wear estimation algorithm is a "learning" scheme, wherein successive estimations of wear are sequentially corrected (up-dated), as measurements of actual wear are compared to the estimation values.

Applicants are concerned with: initial tool length ("Ha"); the calculation of tool length ("Hb") upon an interruption of the machining operation; the calculation of tool wear amount ("Mt"), i.e., a wear estimation; the adjustment of sequential wear correction ("SMs"); and accumulated error amount ("Me") as needed. See Fig 2.

Applicants have the operator load a machining program into their NC machine. This program is never altered. What applicants do is translate (adjust) the program command parameters as a function of working tool wear. For a new tool and a machine which has been set-up, there is not adjustment. Adjustments are made as the machining operation is interrupted and measurements are made. Applicants avoid on-the-fly actual wear measurement and the pitfall errors normally attendant thereto.

When a working tool is replaced, the length Ha is calculated and machining is restarted. The NC machine command parameters are adjusted as a function of accumulated error amount Me. The machining is sequentially interrupted and subsequent tool length Hb is calculated, where after, the tool wear amount Mt is calculated. This value is added to the previous wear amount Me to generate a new wear amount value. If the new sequential wear is a combination with a previous value, the total sequential correction value SMe is subtracted from the accumulated error amount to obtain the incremental wear since the last interruption. The machining operation may then be restarted as needed. See Fig. 3.

Each tool has a wear coefficient ("Mk") which is read prior to beginning or resuming the cutting operation. The cutting length of the tool ("CL") is monitored and a sequential wear

correction value ("SMs") is calculated based upon Mk and CL. Thereafter, a total sequential correction value ("SMs") and a total cutting length ("SCL") of the tool is calculated, and the machine position command parameters are corrected by the total sequential correction value.

When a cutting operation on a workpiece is completed, the tool wear amount Mt is read and the wear coefficient Mk for that tool is renewed as a function of wear amount divided by the tool total cutting length value SCL. See Fig. 4.

Claims 1, 2, 4, 10, 11, and 12 are each being amended herein above. In this regard, the term "setting" has been amended to recited "correcting". Specifically, claims 1 and 4 now recite "correcting a tool edge position of the working tool". Similarly, claim 2 has been amended to recite "said correcting and restarting steps". Claims 10 and 12 have each been amended to recite "a tool edge position control means for correcting a tool edge position of the working tool". Claim 11 has been amended to recite "said tool edge position control means corrects the tool edge position of the working tool".

These amendments find support in the specification at page 15, line 32, to page 16, line 22.

One of the features of the present invention is that a tool edge position of a working tool upon the restart of the machining operation for a workpiece is corrected to coincide with the tool edge position of the working tool upon the interruption of the machining operation for the workpiece, based on the detected wear amount of the working tool.

Since the tool edge position of the working tool upon the restart of the machining operation is corrected to coincide with the tool edge position of the working tool upon the interruption of the machining operation, the present invention can prevent the generation of level difference on the workpiece surface, even if the working tool used prior to the interruption of the machining operation is replaced with a new one after the interruption

of the machining operation and the length of the working tool is changed before and after the interruption of the machining operation. Such level differences to be avoided are shown in Fig. 5.

In contrast, neither Yamazaki nor Huffman discloses the step of correcting a tool edge position of a working tool, upon the restart of the machining operation for a workpiece, to coincide with the tool edge position of the working tool upon the interruption of the machining operation for the workpiece, based on the detected wear amount of the working tool.

The methods disclosed by Yamazaki and Huffman monitor the wear of a tool in the machining process, but do not correct a tool edge position of a working tool upon the restart of the machining operation to coincide with the tool edge position of the working tool upon the interruption of the machining operation. As a result, with Yamazaki and Huffman, if a used tool is replaced with a new one after the interruption of the machining operation thereby providing a new length of the tool, a level difference can be generated on the surface of the workpiece.

Thus, neither Yamazaki nor Huffman disclose the feature of the present invention, and therefore, a person with ordinary skill in the art would not conceive the present invention either the Yamazaki or the Huffman disclosures.

It is requested that the application be re-examined as to the amended claims presented herein, and thereafter be passed to issue.

No additional fees are believed to be required. In the event that an additional fee is required with respect to this communication, the Commissioner is hereby authorized to charge any additional fees, or credit any overpayment, to Paul & Paul Deposit Account No. 16-0750. (Order no. 5179)

Respectfully submitted,
Paul & Paul

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